

1 In the Claims:

3 1. (Currently Amended) A method of applying a gray neutrality
4 calibration to a color signal, said method comprising:

5 representing said color signal as a position in a multi dimensional color
6 space, in which each said dimension of said color space represents a respective
7 primary color;

8 defining a gray axis in said multi dimensional color space as a set of
9 coordinates for which a plurality of said primary colors each have a same value as
10 each other;

11 determining a distance between said position representing said color signal
12 and said gray axis; and

13 using said determined distance between said color signal position and said
14 gray axis to apply a gray neutrality correction to said input color signal; and

15 for color signal having a position corresponding to a maximum saturated
16 value of at least one said primary color, applying a 0 correction to said color
17 signal.

19 2. (Original) The method as claimed in claim 1, wherein said
20 determined distance is determined as a grayness function defined as;

21
$$g(\text{color}) = \min(\text{color}) / \max(\text{color}) \quad \max(\text{color}) > 0$$

22
$$g(\text{color}) = 1 \quad \max(\text{color}) = 0$$

23 where g (color) is the grayness function; and

24 (color) is a value of a color signal.

1 3. (Cancelled).

2 4. (Cancelled)

3 5. (Cancelled)

4

5 6. (Original) The method as claimed in claim 1, wherein said primary
6 colors are non-black primary colors.

7

8 7. (Original) The method as claimed in claim 1, further comprising:
9 applying a first set of gray balancing color corrections to a printer's gray
10 axis, a second set of different color corrections to a printer's gamut surface, and
11 continuously varying intermediate color corrections everywhere else in the gamut;
12 calculating a grayness function which evaluates the distance to the gray axis
13 for a plurality of color signals each carrying a single color data of a multi-
14 dimensional image data;

15 using the value of said grayness function and its complement as weights for
16 a linear combination of two sets of color corrections applied to a said plurality of
17 color signals; and

18 generating an output of said linear combination of color corrections, such
19 that an input into a said color signal channel for a color combination which lies
20 upon the printer's gray axis is affected only by said first set of color corrections, an
21 input into a said color signal channel for a color combination which lies upon the
22 gamut surface is affected only by said second set of color corrections, and an input
23 into a said color signal channel for a color combination which lies in between the
24 gray axis and the gamut surface is affected by both said sets of color corrections,

1 as a function of the distance between said color combination and the gray axis and
2 the distance between the color combination and the gamut surface, respectively.
3

4 8. (Original) The method as claimed in claim 1, further comprising:
5 applying a first set of gray balancing color corrections to a printer's gray
6 axis, a second set of different color corrections to a printer's gamut surface, and
7 continuously varying intermediate color corrections everywhere else in the gamut;
8 calculating a grayness function which evaluates the distance to the gray axis
9 for a plurality of color signals each carrying a single color data of a multi-
10 dimensional image data;

11 using the value of said grayness function and its complement as weights for
12 a linear combination of two sets of color corrections applied to a said plurality of
13 color signals; and

14 generating an output of said linear combination of color corrections, such
15 that an input into a said color signal channel for a color combination which lies
16 upon the printer's gray axis is affected only by said first set of color corrections, an
17 input into a said color signal channel for a color combination which lies upon the
18 gamut surface is affected only by said second set of color corrections, and an input
19 into a said color signal channel for a color combination which lies in between the
20 gray axis and the gamut surface is affected by both said sets of color corrections,
21 as a function of the distance between said color combination and the gray axis and
22 the distance between the color combination and the gamut surface, respectively,
23 wherein the two sets of color corrections are both one dimensional.

1 9. (Original) The method as claimed in claim 1, comprising:
2 generating a multi-dimensional look up table for installation into a printer
3 device for applying a gray neutrality calibration data to a multi-dimensional image
4 data;

5 applying a weighted transfer function to a data input of each of a plurality
6 of color signal channels each carrying a single color data of said multi-
7 dimensional image data; and

8 generating an output of said transfer function, such that an input into a said
9 color signal channel for a color combination which lies upon a gamut surface
10 remains unaffected by said transfer function.

11
12 10. (Original) The method as claimed in claim 1, comprising:
13 generating a multi-dimensional look up table for installation into a printer
14 device for applying a gray neutrality calibration data to a multi-dimensional image
15 data;

16 applying a weighted transfer function to a data input of each of a plurality
17 of color signal channels each carrying a single color data of said multi-
18 dimensional image data; and

19 generating an output of said transfer function, such that an input into a said
20 color signal channel for a color combination which lies upon a gamut surface
21 remains unaffected by said transfer function;

22 wherein said process of generating a multi-dimensional look up table data
23 comprises storing data in each of a plurality of dimensions, each dimension
24 corresponding to a respective color channel.

1

2 11. (Original) The method as claimed in claim 1, comprising:
3 generating a multi-dimensional look up table for installation into a printer
4 device for applying a gray neutrality calibration data to a multi-dimensional image
5 data;
6 applying a weighted transfer function to a data input of each of a plurality
7 of color signal channels each carrying a single color data of said multi-
8 dimensional image data;
9 generating an output of said transfer function, such that an input into a said
10 color signal channel for a color combination which lies upon a gamut surface
11 remains unaffected by said transfer function;
12 identifying a set of individual control points within said multi-dimensional
13 look up table data; and
14 normalizing said control points to a maximum signal value.

15

16 12. (Original) The method as claimed in claim 1, comprising:
17 generating a multi-dimensional look up table for installation into a printer
18 device for applying a gray neutrality calibration data to a multi-dimensional image
19 data;
20 applying a weighted transfer function to a data input of each of a plurality
21 of color signal channels each carrying a single color data of said multi-
22 dimensional image data; and

23

24

25

1 generating an output of said transfer function, such that an input into a said
2 color signal channel for a color combination which lies upon a gamut surface
3 remains unaffected by said transfer function;

4 wherein an input data into said plurality of color signal channels comprises
5 a 4 dimensional image data having data for cyan, magenta, yellow and black
6 colors.

7
8 13. (Original) The method as claimed in claim 1, comprising:
9 generating a multi-dimensional look up table for installation into a printer
10 device for applying a gray neutrality calibration data to a multi-dimensional image
11 data;

12 applying a weighted transfer function to a data input of each of a plurality
13 of color signal channels each carrying a single color data of said multi-
14 dimensional image data; and

15 generating an output of said transfer function, such that an input into a said
16 color signal channel for a color combination which lies upon a gamut surface
17 remains unaffected by said transfer function;

18 said method comprising generating a plurality of said multi-dimensional
19 look up tables, each corresponding to a particular combination of:

20 ink type;

21 media type; and

22 printer resolution.

1 14. (Original) The method as claimed in claim 1, comprising:

2 determining a grayness function defined as:

3 $g(\text{color}) = \min(\text{color}) / \max(\text{color}) \quad \max(\text{color}) > 0$

4 $g(\text{color}) = 1 \quad \max(\text{color}) = 0$

5 where $g(\text{color})$ is the grayness function, and $(\text{color}) c$ is a value of color
6 signal in a said color signal channel.

7

8 15. (Original) The method as claimed in claim 1, comprising:

9 generating a multi-dimensional look up table for installation into a printer
10 device for applying a gray neutrality calibration data to a multi-dimensional image
11 data;

12 applying a weighted transfer function to a data input of each of a plurality
13 of color signal channels each carrying a single color data of said multi-
14 dimensional image data; and generating an output of said transfer function, such
15 that an input into a said color signal channel for a color combination which lies
16 upon a gamut surface remains unaffected by said transfer function;

17 wherein said multi-dimensional look up table comprises an arbitrary
18 number of control points in each said dimension, where the values at each control
19 point are given by the following equations;

20 $c' = g(c, m, y) * GNCc(c) + (1 - g(c, m, y)) * ID(c)$

21 $m' = g(c, m, y) * GNCm(m) + (1 - g(c, m, y)) * ID(m)$

22 $y' = g(c, m, y) * GNCy(y) + (1 - g(c, m, y)) * I - D(y)$

23 $k' = ID(k)$

24 where GNC is a gray neutrality transfer function;

1 ID is an identify transfer function; and
2 g is a grayness function.
3

4 16. (Currently Amended) The method as claimed in claim 1,
5 comprising:

6 generating a multi-dimensional look up table for installation into a printer
7 device for applying a gray neutrality calibration data to a multi-dimensional image
8 data;

9 applying a weighted transfer function to a data input of each of a plurality
10 of color signal channels each carrying a single color data of said multi-
11 dimensional image data; and

12 generating an output of said transfer function, such that an input into a said
13 color signal channel for a color combination which lies upon a gamut surface
14 remains unaffected by said transfer function;

15 wherein said multi-dimensional look up table comprises an arbitrary
16 number of control points in each said dimension, where the values at each control
17 point are given by the following equations;

18 $\text{eeler} = g(\text{color}) * \text{GNCcolor}(\text{color}) + (1 - g(\text{color})) * \text{ID}(\text{color})$

19 $\text{color}' = g(\text{color}) * \text{GNCcolor}(\text{color}) + (1 - g(\text{color})) * \text{ID}(\text{color})$

20 $k = \text{ID}(k)$

21 $k' = \text{ID}(k)$

22 where GNC(color) is a gray neutrality transfer function for a particular
23 color channel;

24 g(color) is a grayness function;
25

1 ID(color) is an identify transfer function for a particular color; and
2 k is a color black signal.

3
4 17. (Currently Amended) A printer device for printing image data, said
5 printer device comprising:

6 a printer mechanism having a media transport mechanism, a printer head
7 mechanism and; a print channel capable of inputting a multi-dimensional image
8 data; and

9 a multi dimensional look up table capable of applying a gray neutrality
10 function to said multi dimensional image data, wherein said multi dimensional
11 lookup table is generated by:

12 representing said color signal and said gray axis; and

13 using said determined distance between said color signal position and said
14 gray axis to apply a gray neutrality correction to said input color signalsignal;

15 wherein said multi-dimensional look up table comprises an arbitrary
16 number of control points in each dimension, wherein the output values at each
17 control point are given by a linear combination of a gray neutrality transfer
18 function GNC and an identity transfer function ID weighted by the grayness
19 function g and its complement respectively.

20

21

22

23

24

25

1 18. (Currently Amended) A printer device for printing image data, said
2 printer device comprising:

3 a printer mechanism having a media transport mechanism, a printer head
4 mechanism and; a print channel capable of inputting a multi-dimensional image
5 data; and

6 a multi dimensional look up table capable of applying a gray neutrality
7 function to said multi dimensional image data, wherein said multi dimensional
8 lookup table is generated by:

9 representing said color signal and said gray axis; and
10 using said determined distance between said color signal position and said
11 gray axis to apply a gray neutrality correction to said input color signal;

12 The printer device as claimed in claim 17, wherein said multi dimensional
13 look up table is generated as an output of a grayness function, said grayness
14 function defined as; defined as:

15 $g(e,m,y) = \min(e,m,y)/\max(e,m,y)$ $\max(e,m,y) > 0$

16 $g(c,m,y) = \min(c,m,y)/\max(c,m,y)$ $\max(c,m,y) > 0$

17 $g(c,m,y) = 1$ $\max(c,m,y) = 0$

18 where $g(c,m,y)$ is the grayness function; and c is a value of a cyan color
19 data; and m is a value of a magenta color data; and y is a value of a yellow color
20 data.

21

22 19. (Cancelled)

23

24

25

1 20. (Currently Amended) A printer device for printing image data, said
2 printer device comprising:

3 a printer mechanism having a media transport mechanism, a printer head
4 mechanism and; a print channel capable of inputting a multi-dimensional image
5 data; and

6 a multi dimensional look up table capable of applying a gray neutrality
7 function to said multi dimensional image data, wherein said multi dimensional
8 lookup table is generated by:

9 representing said color signal and said gray axis; and
10 using said determined distance between said color signal position and said
11 gray axis to apply a gray neutrality correction to said input color signal;

12 The printer device as claimed in claim 17, wherein said multi-dimensional
13 look up table comprises an arbitrary number of control points in each said
14 dimension, wherein the values at each control point are given by the following
15 equations;

16 $c' = g(c, m, y) * GNCc(c) + (1 - g(c, m, y)) * ID - (c)$

17 $m' = g(c, m, y) * GNCm(m) + (1 - g(c, m, y)) * ID(m)$

18 $y' = g(c, m, y) * GNCy(y) + (1 - g(c, m, y)) * ID(y)$

19 $k' = ID(k)$

20 where GNC is a gray neutrality transfer function;

21 ID is an identify transfer function; and

22 g is a grayness function.

1 21. (Cancelled)

2 22. (Cancelled)

3
4 23. (New) A method of applying a gray neutrality calibration to a color
5 signal, said method comprising:

6 representing said color signal as a position in a multi dimensional color
7 space, in which each said dimension of said color space represents a respective
8 primary color;

9 defining a gray axis in said multi dimensional color space as a set of
10 coordinates for which a plurality of said primary colors each have a same value as
11 each other;

12 determining a distance between said position representing said color signal
13 and said gray axis;

14 using said determined distance between said color signal position and said
15 gray axis to apply a gray neutrality correction to said input color signal; and

16 for a color signal having a position on said gray axis wherein said color
17 signal has equal values of each of said plurality of primary colors, applying a full
18 value of said correction.

19

20

21

22

23

24

25

1 24. (New) A method of applying a gray neutrality calibration to a color
2 signal, said method comprising:

3 representing said color signal as a position in a multi dimensional color
4 space, in which each said dimension of said color space represents a respective
5 primary color;

6 defining a gray axis in said multi dimensional color space as a set of
7 coordinates for which a plurality of said primary colors each have a same value as
8 each other;

9 determining a distance between said position representing said color signal
10 and said gray axis;

11 using said determined distance between said color signal position and said
12 gray axis to apply a gray neutrality correction to said input color signal;

13 normalizing each of said primary colors to have values in a range 0 to 1;

14 representing each position on said gray axis by a value of 1; and

15 representing all points on a gamut surface of said color space by a value 0,
16 except where said gray axis coincides with said gamut surface.

17

18

19

20

21

22

23

24

25